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CHEMICAL & ENGINEERING

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CHEMICAL & ENGINEERING NEWS

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JULY 3, 1989

News of the Week

■ **House subcommittee hearing and NIH forum addressing issue of research integrity give hopeful indication that those on both sides of the issue are coming to some accord.** Page 6

■ **Altered version of tissue plasminogen activator, engineered by Texas researchers, may turn out to be an improved anticlotting agent.** Page 7

■ **The American Chemical Society held a full-blown press conference in New York City last week aimed at increasing the society's visibility to the public.** Page 7

■ **President Bush names Johnson & Johnson's Gerard F. Scannell as head of the Occupational Safety & Health Administration.** Page 8

■ **Canada may raise tariffs on U.S. chemicals and plastics products in retaliation for a U.S. Superfund tax on imported oil.** Page 8

■ **CFC producers are accelerating the pace of developing alternatives that don't deplete the stratosphere's ozone layer.** Page 8

Cover: Photo by Gordon Kurzweil/Uniphoto Picture Agency

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Business

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Hearings, reports on solid waste problem bring more Congressional attention to disposal dilemma; EPA Administrator Reilly offers new Superfund strategy. **Page 23**

Science/Technology

Oil industry unveils five-year research, cleanup, and prevention plan to combat future large spills. **Page 28**

Books

In "The Acid Rain Controversy" James L. Regens and Robert W. Rycroft miss the mark by focusing on information pertaining to the U.S., failing to mention important Canadian data. **Page 36**

Meetings

C&EN's semiannual calendar lists meetings and other events of interest to chemists and chemical engineers. **Page 41**

Salary Survey

Chemists' salaries are moderately higher this year; the most recent ACS survey shows median salaries up 5% from the year before, about in line with the rise in living costs. Unemployment among chemists remains at about 1.0% for the third year in a row. Page 31

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LETTERS

Stereotyping scientists

SIR: Why can't chemists, or scientists in general, do what nurses and secretaries, and several other kinds of people, have been doing recently? According to a report in the *New York Times* on April 23, 1989, there have been strong (and well-justified) objections to the portrayal of nurses as stupid sluts in the TV series "Nightingales." As a consequence of pressure on advertisers, the owners of the series have promised to clean up the act next season, and even to snip out some explicit sex scenes from the summer reruns. Secretaries are objecting openly to the airhead stereotypes in TV shows and movies—and they are getting some results. I read, a couple of years ago, that some standup comics in New York were getting laughs by using "Bruce" as a running-gag name for homosexuals. They were, somehow, persuaded to desist.

The stereotype for scientists is "mad," or "evil genius." Oh, yes, that's merely on TV and in movies; and who takes them seriously? Well, just who absorbed the stereotype of Jews, based on Shylock in "The Merchant of Venice"? Millions and millions of people, that's who. It is the images that we receive, over and over again (especially when young) that get into our subconsciousness and that bias people against particular groups—whether Jews, or secretaries, or nurses, or men named Bruce, or chemists.

Can't we start a campaign to redeem the good name of scientist from the subconscious hostility that TV, movies, and novels generate? Movies don't need to portray scientists as wanting to cut up a cute, innocent little extraterrestrial!

If we are to compete with Japan in technology, we can't afford to have our young people turned off by antiscience, antichemistry images, which subtly direct them away from careers in science and engineering.

Robert J. Good
SUNY, Buffalo

Clarification of credit

SIR: In a recent letter (C&EN, June 12, page 3), John J. Eisch of the chemistry department, State University of New York, Binghamton, wrongfully takes us [*J. Am. Chem. Soc.*, **111**, 2316 (1989)] and the Science/Technology Concentrates section of C&EN (March 27, page 26) to task for reporting the isolation of potassium boratirene, and implies that we were deceptive by ignoring his previous findings.

Readers of C&EN may be interested to know that in our communication we give full credit to Eisch for his earlier work: "and Eisch's report that photolysis of. . . ." In our communication we properly report the "first isolation and characterization of a boratirene" (an unsaturated three-membered ring compound containing a tetravalent boron atom). The claim we make for novelty is accurate.

Furthermore, we never allege being the first to observe di-π-methanelike photochemical rearrangements of borates. Indeed, analogous rearrangements were reported by Williams and coworkers in a series of papers dating back to the 1960s [see, for example, *J. Org. Chem.*, **36**, 544 (1971)].

In his recent letter, Eisch raises questions concerning the x-ray structure and optical absorption spectrum of tetraphenylboratirene. These issues will be addressed in their proper forum in due course.

Gary B. Schuster
Michael A. Kropp
Urbana, Illinois

Fast-curing cement

SIR: The excellent article by Pamela Zurer on the fast-curing cement Pyrament (C&EN, Feb. 13, page 37) has exposed several American cement experts and chemists to the debate on the novelty of the formulation. On the one hand, Lone Star's spokesman says, "We're absolutely not going to disclose how we do it." On the other hand, D. M. Roy states, "It would take a fair amount of trouble to find out what's in it, but it probably could be done."

From a European point of view I am surprised at our American colleagues' lack of curiosity. It took us only two days to analyze and find out the formulation of the latest Pyrament brand.

I must admit that, as the primary inventor, I was immediately able to recognize the various ingredients and compounds.

One of the latest published Lone Star patents has confirmed our analytical results. Page 4 of the specification (international publication WO89/02878) outlines the vital role played by the geopolymeric compounds involved in the hardening mechanism with regular portland cement. I quote: "However . . . the inclusion of metakaolin (geopolymeric precursor) is preferable where the utilization in the composition at temperature below the freezing point of water is contemplated. When little or no metakaolin (geopolymeric precursor) is present, there is less durability in the

Oil Industry Unveils Program To Combat Major Spills

Five-year plan for cleanup, prevention, research to cost $250 million, but critics push for tighter controls on oil operations

Richard J. Seltzer, C&EN Washington

Seeking to prevent another spill like the disastrous Alaska oil spill of three months ago, a top-level task force, composed of chief executives or presidents of eight major oil companies, unveiled a comprehensive industry oil-spill program late last month. The firms include Amoco, Atlantic Richfield, BP America, Chevron, Exxon, Mobil, Shell, and Texaco.

Costing more than $250 million over its first five years, the plan deals with prevention, containment, and cleanup of major spills, and research on spill control and mitigation (C&EN, June 26, page 32). The task force was formed in early April by the American Petroleum Institute (API) in response to the massive spill of March 24, when the tanker *Exxon Valdez* released almost 11 million gal of North Slope crude oil into the pristine waters of Prince William Sound—the largest oil spill in U.S. history.

However, the program unveiled at a press conference in Washington, D.C., does not seem to be restoring credibility to the industry, nor to be heading off controls moving through Congress. The program has been greeted skeptically by environmentalists and some members of Congress, who seek legal mandates rather than voluntary actions.

For example, says Rep. George Miller (D-Calif.), chairman of the House Interior Subcommittee on Water, Power & Offshore Energy Resources, "Congress will not rely on the promises of the oil industry. The capability of the industry to respond to major oil spills must be a matter of law, not promises." Adds Sen. Ted Stevens (R.-Alaska), sponsor of a comprehensive oil-spill bill that passed the Senate Commerce Committee on June 20, "there were firm commitments" from Exxon and the Alyeska Pipeline Service Co. "to prevent oil spills, and they were not kept." And at press time the House Appropriations Committee was preparing to vote on a drilling moratorium covering several East Coast and West Coast offshore sites, including Alaska's Bristol Bay.

Murray: speed, decisiveness critical

Moreover, the oil industry's image suffered another black eye on June 23–24, three days after unveiling of the industry plan, when tanker accidents caused oil spills at three widely separated sites within a 24-hour period. Hundreds of thousands of gallons were released at each site—off Newport, R.I., in the Delaware River, and in the Houston Ship Channel.

Indeed, these developments reinforce the judgment by many observers that the *Exxon Valdez* spill was a watershed event, casting doubt on the oil industry's competence and credibility in the way that the explosion of space shuttle *Challenger* rocked the U.S. space program. The efforts by Exxon and Alyeska to deal with the spill have been widely denounced as "unreasonably slow," "confused," and "inadequate," including strong criticism in a report to President Bush by the Environmental Protection Agency and Department of Transportation (C&EN, May 29, page 4).

Nevertheless, in presenting the industry's program at the press conference, task force chairman Allen E. Murray tried to accentuate the positive. Murray is chairman, president, and chief executive officer of Mobil Corp. "Industry has a very good record," with more than 99% safety in transporting oil, he noted. Most spills are relatively small, and in-

Research program to cost more than $30 million

$ Thousands per year*	Years 1-2	Years 3-5
Preventing loss from or retaining oil near ship	$ 150	$ 150
On-water oil recovery & treatment	2650	1850
Preventing & mitigating shoreline impact	3450	1675
Fate & effects of oil in the environment	2100	1100
Wildlife preservation	700	150
Health & safety issues	300	50
TOTAL PER YEAR	$9350	$4975
TOTAL FOR FIVE YEARS	$33,625	

Note: Effort expected to continue at $1 million to $4 million a year after initial five years. *Estimated
Source: American Petroleum Institute

dustry responds well to noncatastrophic spills.

The new program is aimed, therefore, at the infrequent "catastrophic" spills, which are low-risk, high-cost accidents. "These costs include the impact on the environment, the cost to other affected parties, the cost of cleanup, the loss of industry reputation, loss of time to conduct normal business, the loss of business opportunities, and an increased regulatory burden," notes the task force's report.

The size of a spill alone does not define "catastrophic": the type of oil and spill location are also critical. But for planning purposes the group uses 30,000 tons (216,000 barrels or 9.1 million gal) as the threshold, almost the size of the Alaska spill. At present, the report emphasizes, "The industry is not prepared anywhere along the coastal U.S. to deal with a spill of this size."

The program provides a three-pronged attack—tightened standards and improved safeguards for tanker operations; establishment of a Petroleum Industry Response Organization (PIRO) prepared to move quickly to control major spills; and funding of an extensive new R&D program.

"Prevention must continue to be the first line of defense against spills," Murray points out. "This means heavy emphasis on avoiding tanker accidents."

However, the main thrust is establishment of PIRO, with headquarters in Washington, D.C., and five regional response centers covering all coasts. PIRO's goal will be to deploy equipment in response to a 30,000-ton spill within five hours.

"Speed and decisiveness are critical to effective spill response," Murray stresses, "and the procedures in place in the U.S. are hardly conducive to either." Therefore, a key proposal is that the Coast Guard manage major spills, with PIRO providing equipment and personnel. "We need to react immediately," says Murray, with clear-cut authority for such time-critical steps as chemical dispersant use, so as "not to start testing chemicals when oil is on the water."

PIRO's headquarters would carry out research and training, maintain a data bank, and coordinate responses. Regional centers are proposed for the major ports of New York City; Norfolk, Va.; New Orleans; Seattle; and Long Beach, Calif. Total staff would be about 285. Each center would be staffed around the clock and would be capable of responding to a 30,000-ton spill. For larger spills, two or more centers could be mobilized. In addition, Alyeska is to set up a similar oil response center in Valdez, Alaska.

U.S. Coast Guard photo

Boats and booms clean up* Exxon Valdez *oil spill in Alaska's Saw Mill Bay

The task force hopes to have PIRO operating by next summer. So far, 14 firms representing about three quarters of oil shipping have agreed to share costs. It will cost $70 million to $100 million to set up the centers, and $30 million to $35 million a year to operate them.

Throughout the report, needs for research are emphasized. The task force proposes an R&D program of $30 million to $35 million over the next five years, covering the spectrum from basic science (for example, better understanding of the chemical, physical, and biological effects of oil on the environment) to operations (such as use of containment booms in high seas). Priority will go to areas with the greatest potential benefits.

Relatively little progress has been made in the past decade in R&D on oil-spill control and cleanup, notes Eugene A. Renna, president of Mobil's marketing & refining division. Renna explains to C&EN that "there was so much pressure to work on other areas of the environment" that oil spills were put on the back burner. Mechanical devices, such as booms and skimmers, have not advanced greatly. "But not enough has been done on chemical dispersants, either, for example for cold water or freshwater use."

PIRO will contract its research to outside labs, and will cooperate with federal labs, API, individual oil firms, and others. "This is a very large increase in funding for oil-spill research," notes Charles J. DiBona, API president and chief executive officer. The effort is front-loaded to build an enlarged technical base, with $9.4 million allocated for each of the first two years, and $5 million for each of the next three, followed by a projected effort of $1 million to $4 million a year.

R&D on chemical dispersants will get high priority—$1 million of the $2.65 million allocated in each of the first two years for "on-water oil recovery and treatment." In addition in the same category, sorbents, gels, and elastomers will receive $250,000 a year in the first two years. Bioremediation—the use of microbes to biodegrade oil in situ—also will have high priority, receiving $2 million a year in the first two years from the budget for "preventing and mitigating shoreline impact." And research on the biological fate and effects of oil will get $1.5 million a year for the first two years. □

Chemists' Salaries Are Higher; Unemployment Remains Down

This year, as in the two previous years, the employment situation for U.S. chemists seems essentially sound. Returns from the most recent annual survey made by the American Chemical Society of its members' economic status, conducted this past spring, show that very few chemists are involuntarily unemployed.

Only 1.0% of chemists reported that they were jobless and seeking work last March, an unemployment rate essentially unchanged since 1987. In fact, the unemployment rate among chemists has never been significantly below that level since ACS began surveying employment among its members in 1971, which suggests that 1% probably represents as low a level of unemployment as is likely for the profession.

This year, too, the rate is quite similar almost across the board; in the past, women chemists were somewhat more likely to be unemployed than men, and minority chemists more likely than whites. As in previous years, however, the jobless rate for chemists who do not have a graduate degree is a bit higher than that for those who do. The overall rate of unemployment this year is less than half what it was when it hit 2.2%, its highest level in over a decade, six years ago.

Chemists report, too, that they are making more money this year. Median base salaries for chemists, as of March 1, are 5% higher than a year earlier, whatever their level of training. This rate of increase is in line with the average annual growth in salaries over the past 10 years or so.

But the Bureau of Labor Statistics' index of consumer prices likewise increased 5% in the 12 months through March 1989. So factoring the rate of inflation into the picture, the recent salary improvement essentially is wiped out. In fact, after adjustment for higher living costs, the median salary for chemists with either a B.S. or an M.S. degree is a bit less this year than it was in 1980. And for those with a Ph.D., the median, in constant dollars, is only slightly higher now than it was then. Individuals would have fared better, to be sure, be-

Unemployment is low for ACS members, whatever their gender, training, or background

	Chemists									
		By sex		By highest degree			By minority status		Chemical engineers	All members[c]
Employment status[a]	Total	Men	Women	B.S.	M.S.	Ph.D.	Minority[b]	Nonminority		
Employed full time	94.4%	95.2%	90.8%	95.5%	95.7%	93.6%	91.8%	94.6%	94.6%	94.4%
Employed part time	1.5	1.0	3.6	1.4	1.8	1.4	1.8	1.5	1.7	1.5
Postdoctoral or fellowship	2.1	2.0	2.8	0.1	0.1	3.6	5.2	1.9	0.6	2.2
Unemployed										
Seeking employment	1.0	1.0	1.0	1.5	1.1	0.8	0.7	1.0	1.5	1.0
Not seeking employment	0.9	0.7	1.9	1.5	1.3	0.6	0.5	1.0	1.6	0.9

a As of March 1, 1989. b Black, Spanish/Hispanic, American Indian, Alaskan native, Asian, Pacific Islander, or other. c Includes ACS members whose highest degree and present work are in neither chemistry nor chemical engineering. **Source:** ACS survey

Increase of 5% in chemists salaries in past year is in line with recent trend

												Annual change		
$ Thousands	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1988–89	1984–89	1979–89
CHEMISTS' MEDIAN SALARIES[a]														
B.S.	$37.0	$35.4	$33.5	$33.0	$32.0	$30.9	$30.0	$28.5	$27.5	$25.0	$23.5	5%	4%	5%
M.S.	43.0	41.0	39.0	37.9	36.0	34.0	33.0	31.6	30.0	26.0	25.0	5	5	6
Ph.D.	52.5	50.0	47.7	47.8	44.0	42.0	40.0	37.5	35.0	31.2	29.0	5	5	6
All chemists	47.3	45.0	42.5	42.5	40.0	38.0	36.0	34.7	32.0	28.9	na	5	4	na

a Base annual salary as of March 1. na = not available. **Source:** ACS survey

Salaries tend to rise most markedly during the first 20 to 30 years of a chemist's career

Years since B.S. degree	Median salary ($ thousands)[a]									
	0 to 1	2 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	Overall
NONACADEMIC CHEMISTS											
B.S.											
90%	$31.5	$35.0	$43.0	$50.9	$58.0	$66.4	$70.0	$76.0	$ 88.0	$ 71.0	$60.0
75%	28.5	31.0	37.0	44.1	50.0	57.4	60.0	60.0	65.9	59.1	48.4
50%	25.5	26.9	32.0	38.0	42.0	47.9	48.4	50.0	55.9	51.8	37.4
25%	21.3	23.0	27.9	31.9	35.2	40.2	40.0	40.0	44.9	40.0	29.4
10%	19.3	20.0	24.6	26.5	30.0	30.3	32.0	35.0	35.0	33.0	24.2
M.S.											
90%	—	37.0	44.0	52.0	62.0	70.8	74.6	72.0	80.0	86.0	66.6
75%	—	35.0	39.1	46.2	55.0	60.0	60.0	66.6	63.9	66.0	56.0
50%	—	33.0	35.0	40.2	44.5	50.0	53.1	54.8	53.0	58.6	45.0
25%	—	29.0	31.2	36.0	39.0	41.0	43.0	45.0	45.0	50.0	37.0
10%	—	26.3	27.0	31.2	34.5	32.5	36.6	37.0	40.0	43.0	31.2
Ph.D.											
90%	—	—	50.0	60.0	72.0	84.0	91.0	91.6	102.0	100.0	84.0
75%	—	—	47.1	53.6	61.1	72.0	77.7	77.0	85.0	79.6	70.0
50%	—	—	44.3	48.5	55.0	62.0	65.5	66.2	70.6	69.0	57.0
25%	—	—	41.5	44.0	48.0	52.1	55.9	55.0	60.0	55.0	47.5
10%	—	—	38.7	40.0	42.2	45.0	45.0	45.7	50.1	46.0	42.0

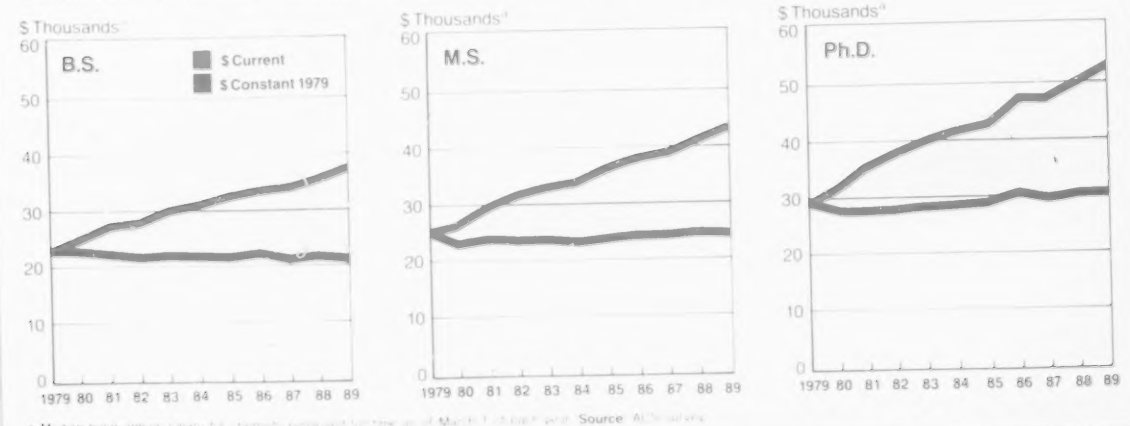
How to read this table: Using, as an example, nonacademic B.S. chemists two to four years after they have received their B.S. degree: 90% of these chemists have annual base salaries of $35,000 or less; 75% have annual base salaries of $31,000 or less; 50% have annual base salaries of $26,900 or less; 25% have annual base salaries of $23,000 or less; and 10% have annual base salaries of $20,000 or less (as of March 1, 1989). [a] As of March 1, 1989. **Source:** ACS survey.

cause their own salaries depend not only on the overall level of salaries for all members of their profession but also on how long they have been active in their career.

Few chemists, of course, actually earn a salary at the median level for the profession as a whole. (The median is the salary that is exceeded by 50% of the respondents to the survey; it indicates more accurately than the mean a typical salary for a group of individuals.) To compare one individual's earnings with those of his or her peers, therefore, it is more meaningful to look at median salaries for smaller, more similar groups within the profession. Salaries are dependent on the type of work that chemists do, who they work for, and how long they have been working, among other things.

One thing clearly evident is that women chemists continue to earn less than their male colleagues. In part, this is because women, as a group, have less experience. For example, nearly 80% of the nonacademic respondents who are women received their B.S. degree less than 20 years ago, compared with only about half the men. But even adjusting the salaries to account for this difference, the averages (rather than the medians) for women's salaries are still only roughly 80 to 90% those of men, a differential that has not changed significantly during the past half dozen years or so. The gap typically is relatively slight—or even nonexistent—between less experienced men and women chemists but

Salaries of chemists continue to climb, but are relatively static if adjusted for inflation



[a] Median base annual salary for chemists employed full time as of March 1 of each year. **Source:** ACS survey.

widens markedly as their careers lengthen.

At least part of the reason probably lies in differences in the type of work or the level of responsibility that show up between men and women. In industry, men chemists are twice as likely as women to hold management positions, the jobs for which salaries tend to be highest. In addition, nearly 30% of the women report they work as analytical chemists, compared with only about 20% of the men, and women also are more likely than men to hold jobs as biochemists or environmental chemists. These are specialties for which salaries typically are lower than those, for example, in materials science, physical chemistry, or polymers, specialties where men are overrepresented.

Similarly, in the academic community, relatively few women have attained the rank of full professor. Only 26% of the women on the chemistry staffs of colleges and universities are full professors, another 26% are associate professors and 29% are assistant professors. In contrast, 56% of the men are full professors, whereas only 19% are associate and 15% assistant professors. Moreover, only 45% of the men responding to the survey but nearly two thirds of the women teach at schools that do not have a Ph.D. program, where salaries generally are lower than those paid by Ph.D.-granting universities.

Base salaries are not the only remuneration that chemists may earn, to be sure. About 45% of the industrial chemists responding to the sur-

Industrial chemists' salaries vary from industry to industry

Industry	% of industrial chemists				Mean salary ($ thousands)[a]		
	All chemists	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Pharmaceuticals[b]	18%	16%	21%	19%	$42.4	$50.7	$64.9
Specialty chemicals	15	15	14	16	45.7	51.3	61.6
Basic chemicals	7	4	5	9	46.3	50.0	64.6
Plastics	6	6	5	7	46.2	52.2	64.2
Electronics	5	4	5	5	46.2	52.5	62.2
Petroleum and natural gas	4	4	3	5	44.4	56.3	69.5
Food	4	5	4	3	41.5	49.6	59.9
Coatings	4	6	4	3	41.6	48.5	56.3
Agricultural chemicals	3	3	3	4	37.5	47.3	62.2
Metals and minerals	2	3	3	1	39.6	46.1	56.1
Biochemical products	2	1	2	3	38.7	52.7	61.1
Rubber	2	2	1	1	45.5	50.8	57.1
Soaps and detergents	1	2	1	1	39.4	53.4	57.3
Paper	1	1	1	1	41.8	44.7	54.4
Other manufacturing	15	15	16	14	42.1	50.5	58.9
Nonmanufacturing	10	14	12	7	39.0	48.2	61.2

a As of March 1, 1989; to facilitate comparison, mean salaries are adjusted for differences in average length of experience for each group. b Includes personal care products. **Source:** ACS survey

In academia, full professors earn considerably more than those ranked lower

Years since B.S. degree	Median salary ($ thousands)[a]								
	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	Overall
Ph.D. CHEMISTS EMPLOYED FULL TIME IN ACADEMIA									
Ph.D.-granting schools									
Professor	—	—	$61.2	$62.2	$65.3	$69.3	$67.0	$82.2	$67.1
Associate professor	—	$48.0	48.8	45.6	46.2	(50.0)	—	—	48.3
Assistant professor	$40.1	40.3	40.5	—	—	—	—	—	40.3
All ranks[b]	37.2	40.3	47.6	54.9	59.6	67.1	65.6	76.7	54.9
Non-Ph.D.-granting schools									
Professor	—	—	(46.0)	51.0	51.2	55.4	56.8	60.0	53.2
Associate professor	—	(45.1)	40.9	43.9	41.5	43.0	—	—	42.7
Assistant professor	35.4	34.2	31.1	(34.0)	(42.7)	—	—	—	34.2
All ranks[b]	31.7	34.2	35.4	45.1	48.4	52.4	54.9	58.6	45.1

Note: Where no salary data are shown, sample is too small to provide a meaningful figure; data in parentheses are from relatively small samples, as well, and should be viewed with caution. a Base annual salary as of March 1, 1989, excluding summer teaching and other supplemental earnings; salaries of the approximately 60% of academic chemists who have nine- or 10-month contracts are adjusted to a 12-month basis. b Includes instructors, lecturers, research associates, and others not listed separately. **Source:** ACS survey

Salaries of women chemists range about 10 to 20% below those of their male colleagues

Mean salary, $ thousands[a]	B.S.				M.S.				Ph.D.			
	All chemists	Men	Women	Women as % of men	All chemists	Men	Women	Women as % of men	All chemists	Men	Women	Women as % of men
EMPLOYER												
Private industry	$41.6	$44.5	$37.6	85%	$48.8	$50.6	$44.1	87%	$62.3	$63.3	$54.8	87%
Academic	28.5	32.5	24.7	76	34.5	37.4	29.7	79	46.6	47.7	39.8	83
Government	36.9	38.7	35.2	91	41.0	43.4	39.1	90	54.2	55.4	44.2	80
Other	40.3	44.3	33.4	75	48.9	51.2	43.5	85	60.8	62.9	50.0	79

a As of March 1, 1989; to facilitate comparison, salaries are adjusted for differences in average length of experience between men and women. **Source:** ACS survey

Research chemists tend to earn less than managers, women less than men in industry

Years since B.S. degree		Median salary ($ thousands)[a]										
		0 to 1	2 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	Overall
CHEMISTS EMPLOYED FULL TIME IN INDUSTRY												
Sex												
Men	B.S.	$26.0	$28.8	$34.0	$40.0	$44.0	$50.0	$53.4	$55.0	$56.6	$54.0	$41.0
	M.S.	—	(34.2)	36.5	41.0	46.8	54.0	54.2	55.3	56.0	59.6	48.0
	Ph.D.	—	—	44.8	49.8	55.5	64.0	69.1	68.5	74.0	72.0	59.6
Women	B.S.	25.6	26.4	31.0	38.0	39.2	36.2	40.0	(42.0)	—	—	31.0
	M.S.	—	(33.0)	34.5	40.0	42.4	44.5	(42.0)	(49.9)	—	(60.0)	39.3
	Ph.D.	—	—	45.0	48.0	55.3	61.8	(48.0)	(51.6)	—	—	48.0
Work function												
General management	B.S.	—	—	38.0	42.7	43.2	(49.0)	(48.0)	(62.0)	70.2	—	45.0
	M.S.	—	—	(37.6)	41.0	(49.9)	(49.7)	(51.6)	(55.0)	(76.2)	(60.0)	48.3
	Ph.D.	—	—	—	—	59.5	68.0	82.3	85.0	100.0	(69.4)	73.0
R&D management	B.S.	—	—	—	45.8	(54.0)	(54.5)	(64.5)	(60.0)	61.8	—	55.0
	M.S.	—	—	—	(47.5)	59.5	60.8	(61.5)	(67.8)	60.0	(66.3)	58.0
	Ph.D.	—	—	(46.6)	54.5	65.0	72.5	75.0	79.5	86.0	88.0	72.2
Basic research	B.S.	(29.0)	28.2	32.0	(36.8)	(39.7)	—	—	—	—	—	31.1
	M.S.	—	—	34.1	40.2	43.0	—	(54.0)	—	—	—	42.0
	Ph.D.	—	—	44.0	49.7	52.8	62.2	63.0	68.4	66.6	—	53.0
Applied research[b]	B.S.	26.7	28.0	33.0	38.0	41.4	43.0	45.0	46.4	51.0	(46.1)	36.0
	M.S.	—	(33.4)	36.2	40.0	42.6	50.0	54.5	47.0	56.5	60.0	43.0
	Ph.D.	—	—	45.0	48.0	53.0	58.7	63.0	62.8	63.8	63.1	53.0
Production[c]	B.S.	(25.5)	25.0	31.9	35.5	38.0	(50.6)	46.0	(48.2)	(50.5)	—	35.0
	M.S.	—	—	(35.5)	39.6	43.0	44.0	(48.0)	(55.3)	(50.0)	—	42.6
	Ph.D.	—	—	—	(44.0)	(46.0)	53.6	(58.0)	(54.1)	—	—	53.0
Marketing[d]	B.S.	—	28.4	32.5	40.0	50.6	52.5	(50.0)	(60.5)	(57.3)	—	44.0
	M.S.	—	—	(36.0)	40.5	50.6	(47.3)	(56.5)	—	(51.5)	—	47.0
	Ph.D.	—	—	—	(49.8)	(57.5)	66.7	(64.0)	(58.5)	—	—	57.0
Work specialty												
Agricultural and food chemistry	B.S.	—	—	(30.1)	(39.5)	—	—	—	—	(53.0)	—	40.0
	M.S.	—	—	—	—	—	(43.0)	—	—	—	—	48.6
	Ph.D.	—	—	(45.0)	45.9	(52.8)	(53.1)	64.0	(70.5)	(67.4)	—	54.0
Analytical chemistry	B.S.	25.4	26.2	32.9	37.2	40.8	46.1	50.0	45.8	49.8	—	35.0
	M.S.	—	—	35.0	40.0	42.0	51.1	49.3	50.5	(55.0)	(60.0)	42.8
	Ph.D.	—	—	45.0	47.0	55.0	62.5	65.0	60.8	70.3	(72.3)	52.0
Biochemistry	B.S.	—	(28.9)	(35.6)	—	—	—	—	—	—	—	34.3
	M.S.	—	—	(34.8)	(39.6)	(48.0)	—	—	—	—	—	40.0
	Ph.D.	—	—	(46.0)	50.0	53.6	68.5	(55.9)	(63.5)	(94.0)	—	54.6
Environmental chemistry	B.S.	(22.0)	26.0	33.2	40.9	(39.3)	(46.0)	—	(48.0)	—	—	37.0
	M.S.	—	—	(35.0)	40.5	(44.3)	—	—	—	—	—	43.0
	Ph.D.	—	—	—	—	(53.0)	63.7	(59.5)	—	(90.0)	—	54.5
Inorganic chemistry	B.S.	—	—	(31.8)	—	—	—	—	—	—	—	39.0
	M.S.	—	—	—	—	—	—	—	—	—	—	(48.5)
	Ph.D.	—	—	(46.5)	52.6	53.9	(67.0)	(78.8)	—	—	—	56.8
Materials science	B.S.	—	(29.6)	(30.0)	(40.0)	(40.0)	—	—	(57.8)	(75.0)	—	40.0
	M.S.	—	—	—	(37.9)	—	(60.0)	(50.0)	—	(55.5)	—	52.0
	Ph.D.	—	—	(45.9)	50.8	55.0	63.5	69.6	(66.9)	(65.0)	(68.1)	60.0
Medicinal and pharmaceutical chemistry	B.S.	—	(31.1)	(34.8)	(35.0)	(43.3)	(48.8)	—	—	—	—	36.8
	M.S.	—	—	(34.2)	(38.2)	(47.0)	(50.9)	(51.0)	—	—	—	43.0
	Ph.D.	—	—	(45.2)	52.2	57.6	69.0	79.0	(71.5)	80.0	(71.3)	61.2
Organic chemistry	B.S.	—	28.0	30.5	40.0	(43.8)	(44.5)	(46.8)	(55.5)	(52.5)	—	38.9
	M.S.	—	—	(35.2)	41.4	45.0	(49.0)	(54.1)	(48.2)	(51.9)	—	45.0
	Ph.D.	—	—	43.9	48.0	54.8	65.0	68.2	68.7	69.0	(65.6)	56.4
Physical chemistry	B.S.	—	—	—	—	—	—	—	—	—	—	46.5
	M.S.	—	—	—	—	—	—	—	—	—	—	55.2
	Ph.D.	—	—	(45.3)	51.0	58.0	61.6	60.0	63.0	(74.5)	(78.4)	59.3
Polymer chemistry	B.S.	—	30.0	32.0	40.0	50.5	48.0	(58.4)	(60.7)	60.0	—	42.0
	M.S.	—	—	35.9	(45.0)	46.6	(58.5)	57.5	(65.6)	(50.0)	(57.2)	47.2
	Ph.D.	—	—	44.6	48.1	56.0	66.0	68.7	66.1	71.0	74.0	60.0

Note: Where no salary data are shown, sample is too small to provide a meaningful figure; data in parentheses are from relatively small samples, as well, and should be viewed with caution. a As of March 1, 1989. b Includes development and design. c Includes quality control. d Includes purchasing, technical service, and economic evaluation. **Source:** ACS survey

For the third straight year, unemployment continues to be very low for chemists

Employment status[a]	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979
Employed full time	95.3%	95.4%	95.4%	94.8%	95.2%	93.7%	93.5%	94.9%	95.6%	95.9%	95.0%
Employed part time	1.5	1.6	1.5	1.5	1.5	1.7	1.7	1.4	1.1	1.0	2.0
Postdoctoral or fellowship	2.2	2.0	2.0	2.0	1.9	2.9	2.6	2.2	2.2	2.2	1.9
Unemployed	1.0	1.0	1.1	1.7	1.4	1.7	2.2	1.5	1.1	0.9	1.1

a As of March 1, 1989; excludes chemists who are not employed but not seeking employment. Source: ACS survey

vey, for example, report they also received a bonus last year. As would be expected, the largest bonuses go to managers, with the median being $9000 for chemists working in general management functions ($12,000 for those with a Ph.D.) and $8000 for those in R&D management. For chemists in marketing who received a bonus, the median is $5000. Bonuses generally are lower for chemists in research or other functions.

Academic chemists, as well, can supplement their professional income—with consulting fees, earnings from a second job, summer teaching, and the like. This is especially true for professors working on nine- or 10-month contracts (which is what the majority of them have) rather than 11- or 12-month contracts. Thus the median total income last year for full professors with nine- or 10-month contracts, the ACS survey indicates, was $54,000, although their current annual base salary is $48,000; the median total income for those with 11- or 12-month contracts was $70,000, $67,000 of which came from their base salary. The median amount of supplemental income for associate professors with nine- or 10-month contracts was $4400, for assistant professors $4600.

Professors employed by public schools earn more supplemental income than those at private schools, the survey indicates. And such income is considerably greater for professors at universities that have Ph.D. programs than for those at schools that do not. It also is greater, not surprisingly, for professors who devote more of their time to research than to teaching.

Although just 1.0% of chemists surveyed were unemployed and looking for work last March, 3.6% of the respondents report they were jobless sometime during 1988. The length of unemployment for those out of work generally was not long, though. About 60% report that they were without a job for less than four months; only 16% were unemployed for more than six months.

These statistics on the current economic status of chemists are based on nearly 12,000 responses to a mail survey of a random sample of ACS members undertaken earlier this year by the ACS Market & Business Analysis Department for the Member & Professional Services Department. The survey was limited to members with U.S. mailing addresses who are not students, retired, or emeritus members and who are not over the age of 70.

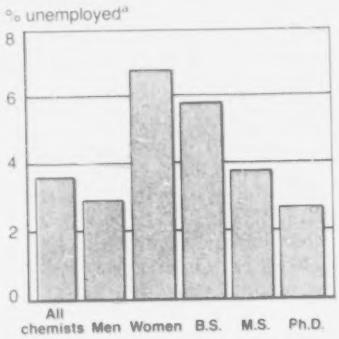
A considerably more detailed report on the survey is available in the publication "Salaries 1989," which can be purchased from the ACS Distribution Office, Room 210, American Chemical Society, 1155—16th St., N.W., Washington, D.C. 20036. The price of this year's report is $150. Questions or comments regarding the survey can be directed to Joan Burrelli at ACS headquarters, (202) 872-4433. □

Unemployment is low whatever chemists do

	% of chemists in category	% unemployed[a]
Industry	58%	1.0%
Academic	24	0.8
Government	10	0.4
Other	8	2.5
R&D	43%	0.7%
Teaching	12	0.6
R&D management	12	0.4
General management	9	1.7
Marketing[b]	7	1.8
Production[c]	5	1.1
Other	12	2.1
Analytical	20%	0.9%
Organic	14	1.1
Polymer	11	0.9
Biochemistry	9	0.6
Environmental	8	1.8
Physical	7	0.8
Medicinal[d]	8	0.5
Inorganic	5	0.8
Agricultural and food	4	0.7
Other chemistry	14	1.1

a As of March 1, 1989; excludes chemists who are not employed but not seeking employment. b Includes purchasing, technical service, and economic evaluation. c Includes quality control. d Includes pharmaceutical and clinical chemistry. Source: ACS survey

Fewer than 4% of chemists jobless anytime in 1988



a Excludes chemists who were not employed but not seeking employment. Source: ACS survey

Most chemists unemployed last year had work within few months

Months unemployed during 1988	Less than 1	1 to 3	4 to 6	7 to 12
All chemists	12%	48%	24%	16%
Men	12	47	27	15
Women	13	56	21	10
Highest degree				
B.S.	15	56	20	9
M.S.	7	52	27	14
Ph.D.	12	45	26	17

Note: Excludes chemists not in the labor force March 1, 1989. Source: ACS survey